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ABSTRACT

The Zimbabwe Secondary School Science Project (ZIM-SCI) developed student study guides, corresponding teaching guides, and science kits for a low-cost science course which could be taught during the first 2 years of secondary school without the aid of qualified teachers and conventional laboratories. This teaching guide, designed to be read in conjunction with the related student guide, includes instructional strategies, lists of required materials, laboratory procedures, and other information for a three-part unit in which students investigate: (1) the chemical compounds found in the earth's crust and atmosphere; (2) the characteristics of metals and non-metals; and (3) the extraction of iron from red iron oxide and the purification of copper. Each section in this guide corresponds to a given section in the student study guide. (JN)

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ZIM-SCI

ZIMBABWE SECONDARY SCHOOL SCIENCE PROJECT

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TEACHER'S GUIDE UNIT F2

The Chemicals of the Earth

SE 043 848

UNIVERSITY OF ZIMBABWE
AND MINISTRY OF EDUCATION AND CULTURE

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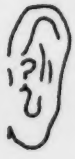
August 1982.

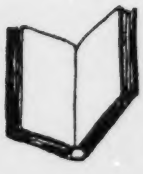
The following symbols will be used to indicate the points in the lesson at which teacher activity is particularly important. These symbols also appear at the corresponding points in the pupil study guides

Practical work. The necessary instructions for each experiment will be given to you when you see this symbol

Written exercises for the pupils. If possible these should be put on the blackboard before practical work begins so that the pupils can see what to look for



Teacher information The pupils will need extra guidance at these points The information they will need from you is given where you see this symbol



This symbol appears at a point where it is necessary for pupils to think over what they have done in the past few lessons. Set aside a period for this review activity. Encourage the pupils to read over their notes and the study guide section which they have just covered. It may be helpful to ask them to write a summary too.

The following symbols which appear only in the Teacher s Guide are used to indicate important points for you the teacher

Take note of an important point

This symbol indicates a preparation of apparatus which should be done well ahead of time. Please read these notes carefully and carry out the instructions well in advance.

We have placed this symbol next to experiments where we feel there may be a possible danger. Please read the section carefully so that you know about the particular danger in that experiment. It would also be wise to refresh your memory on the appropriate safety or first-aid procedures described in the Zim-Sci Handbook.

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TEACHER'S GUIDE

AIMS OF THIS UNIT

When you have completed this study unit pupils will be able to:

1. Explain by means of pie charts the rough composition of the earth.

2. Describe the composition of air and the effect of burning various elements.

3. Describe chemical tests for some gases.

4. Describe some characteristics of metals.

5. Explain that most common metals are reactive and thus found as compounds

6. Describe how some metals may be extracted from ores by reduction and using electrical energy

CONCEPT DEVELOPMENT IN THIS UNIT

This unit is mainly a chemical one, designed to expand the pupils knowledge and to introduce them to systematic chemistry. It is important that pupils realise early in their scientific experience that chemistry is a logical science and that very little need be guesswork or pure learning work.

Broadly, the development is as follows:

Part I. This section extends the work done in unit F1, to a closer look at the chemicals of the earth and the atmosphere. The composition of both earth and air is given and the main active component of air is seen to be oxygen. The action of oxygen on other elements is examined, firstly with a view to proving that oxygen occupies 1/5 of the air, and then that it causes rusting and tarnishing. The connection with burning is then made (Experiment 3). Similar experiments are then conducted with carbon dioxide. By the end of Experiment 5, pupils should be familiar with methylene blue and bicarbonate indicator.

The idea of an indicator is then extended to Universal Indicator Paper, and the pH scale is mentioned. Acid and base develop from this, and addition of an acid to a base is examined. The existence of acidic and basic oxides is then demonstrated as a conclusion to Part I.

Part 2 begins with a classification of elements on the nature of their oxides. It is then seen that this also provides for a metal/non-metal classification. Other properties of metals and non-metals are then examined so that the physical properties of a metal are understood. Once this has been done, a simple classification of metals according to their activity is possible (Experiment 8). Finally, reactions of some metals with sulphur are carried out.

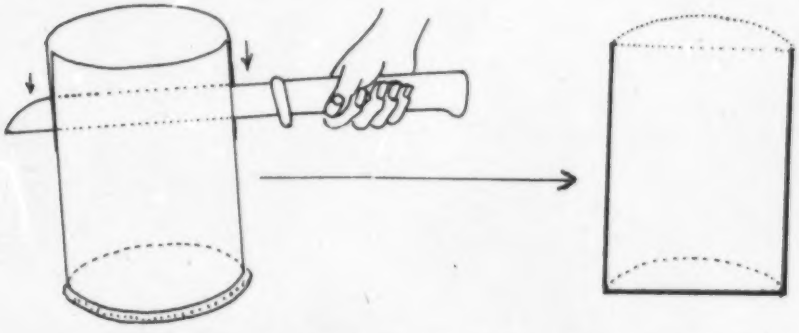
Part 3 of the Unit deals with the principles behind the extraction of metals. Occurrence as metallic oxides and sulphides is mentioned to tie in with Parts 1 and 2. Lastly, the industrial extraction of iron and refining of copper are imitated in simple experiments.

When pupils have completed this Unit, they should have a much greater understanding of chemistry. The SYSTEMATIC approach should be emphasised all the time.

Making Scientific diagrams

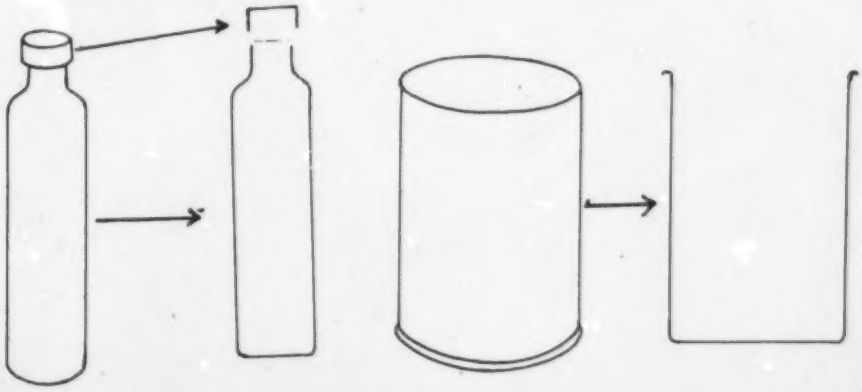
Pictures of apparatus have been used in previous units to help the pupils see what apparatus they should use and how to use it. You might already have noticed that the pupils spend a long time trying to reproduce the pictures and may enjoy doing it. However, they do not learn any more science by drawing three dimensional pictures, than by using simple diagrams.

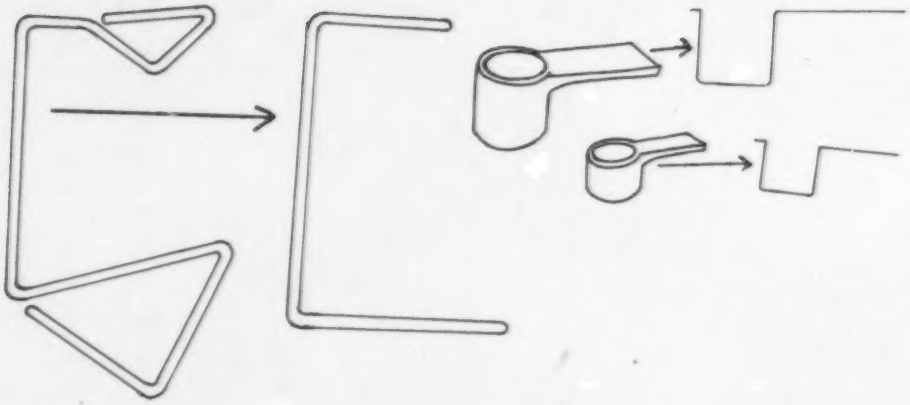
You can explain to the class how simple sectional diagrams are made. They should imagine that a piece of apparatus is cut through the middle with a knife, and then the cut edge is drawn. Put this picture on the board.

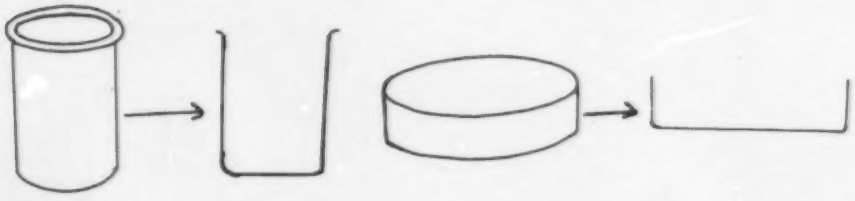


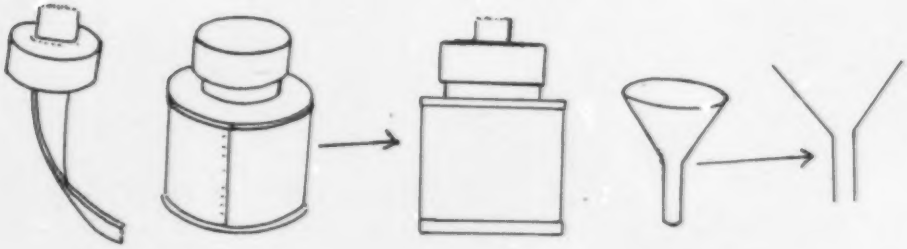
Here are some more illustrations of the rest of their kit. Their study guide also contains some diagrams for them to refer to.

As from this unit F2 the Zim-Sci course will be using (cross sectional) simple diagrams and you should make every effort to see that the pupils use them too.



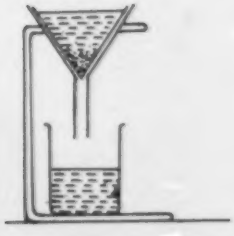




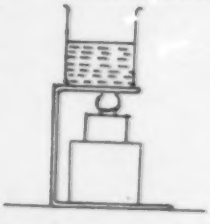


Examples of assembled sectional diagrams of:

Filtration



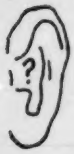
Evaporation of water



TEACHER'S GUIDE

UNIT F2 : THE CHEMICALS OF THE EARTH

Part 1: The earth and the atmosphere.

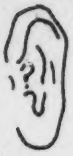


Introduction Page 3

Please read this through with your students. The remembering of elements is really a revision exercise. Try to remind pupils of all the elements that they met in Year 1. For your guidance only the list of most common elements is given below. Other chemicals that they suggest will be compounds. Do not give them any names: let all the answers come from them!

(The list includes suggestions where the pupils might have met the name of the element before)

Aluminium - foil
Arsenic
Barium
Beryllium - mined in this country
Boron
Bromine
Calcium
Carbon
Chlorine - water purification
Chromium
Cobalt
Copper - jewelery wire
Fluorine - small traces in toothpaste
Gold - jewellery
Helium
Hydrogen
Iodine in medicine
Iron iron filings used in 'Cl
Lead
Lithium
Magnesium - ribbon
Manganese
Mercury - in thermometers
Molybdenum
Neon - neon lights
Nickel - mined in Zimbabwe
Nitrogen - fertilizer
Oxygen in air
Phosporus
Platinum
Potassium
Radium
Silicon
Sulphur - powder they have used
Silver - precious metal
Sodium - in salt
Tin
Tungsten in light bulb
Uranium in atomic bomb
Zinc - bath tub



Page 4 Compounds containing oxygen. Your pupils may remember that copper sulphate is a compound of copper, sulphur and oxygen. Other compounds they know which contain oxygen are:

potassium permanganate
potassium nitrate
ammonium dichromate
sodium thiosulphate

Can they notice any similarity between these chemical names?
The ending 'ate' indicates that a chemical contains oxygen. Other oxygen-containing compounds are mealie meal, methylated spirits and sugar.

There are many more!

Page 5 Properties of a mixture. Please make sure that pupils remember the main properties which they learnt in Unit C1.

Page 6 Experiment 1, A magic trick.

Before you begin this experiment, you will need to prepare methylene blue indicator. This indicator is blue in the presence of oxygen, and is white when there is no oxygen present. Do not tell your pupils this fact until later!

Preparation of methylene blue indicator.

You will need:

methylene blue powder
water
spatula
graduated beaker
2 ml measure
dropper
conical flask
2 small bottles with lids (for storage)

Note: be careful: Methylene blue is like ink. It will stain your fingers and clothes.

8

1. Using your spatula, put methylene blue powder into the 2 ml measure until it is half full.

2. Put this powder into the graduated beaker and fill with water. Stir well. This is your STOCK solution of methylene blue which can be stored for future use in your small bottles. Keep them in your cupboard.

3. For pupil use, you will need a weaker solution. Using your dropper, half fill the 2 ml measure with the solution of methylene blue which you have made. Pour this concentrated solution into the conical flask and add water to the 250 ml mark. The solution should now be a very pale blue and is ready for use by the pupils.

Having made up the methylene blue indicator you can now use it in making up the flask of "magic water"

You will need:

- conical flask and cork (rubber stopper)
- water
- sodium hydroxide pellets
- glucose powder
- balance
- sheet of clean paper
- measuring cylinder
- stock solution of methylene blue
- dropper

Put 150 ml water into the conical flask. Place the sheet of paper on the scale pan and weigh out 4 g sodium hydroxide pellets. Add the pellets to the conical flask. Swirl gently until the pellets dissolve.

Take great care not to touch the pellets or get sodium hydroxide solution on your hands as it is a strong alkali. If you do spill some, wash off with lots of water.

Allow to cool.

Weigh out 5 g glucose powder. Add to the cooled sodium hydroxide solution - swirl again until it dissolves.

Add 4 - 5 drops methylene blue solution drop by drop until the solution is a visible blue, but not too dark.

Cork up the flask. You will find the colour fades in 1 - 2 minutes.

If you give it a good shake, the blue colour will return.

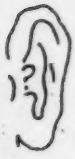
It is now ready to use

<u>To do the magic trick.</u>

The aim of the trick is to show the pupils that the solution is turning white without your touching it at all. They will be very surprised to see this happen. The bigger the 'build-up' you can give it, the better and the more they will remember it!

Start off with the solution blue (just shaken)

Put it on your desk in front of the class.



You might like to read the following to your pupils:

> "Here I have a flask of magic water! This water cannot make up its mind what colour it would like to be! Watch it as it tries to decide whether it would like to be white or blue!"

At this point you should not touch the flask. As the oxygen is removed from the solution by the chemicals, the indicator will turn colourless. Continue to talk to the pupils:

> "Ah, the solution would like to be white! Well, I shall change its mind again!"

Give the flask a good shake. This will re-oxygenate the water and it should go back to a blue colour. You can repeat this trick as many times as you (or the pupils!) care to watch it. It will not keep for a long period, though. Do not try to carry over the same solution from one day to the next.

Once the pupils have watched the trick, ask them if they can suggest how it works. Ask them to study the surface of the colourless solution - they should see the surface turning blue first. This should indicate to them that the air has something to do with it. After they have reached this conclusion, you can tell them that the blue colour is a chemical called methylene blue, and that it detects the presence of oxygen. Explain that the chemicals in the flask are 'oxygen gobblers'- that they react with any oxygen and remove it. This is why the methylene blue loses its colour. They can then answer Exercise 1.

Exercise 1. page 6

Describe what you observed in your teacher's magic trick. Explain how it happened. Write down the colours that methylene blue gives in oxygen and without oxygen

Safety note.

When disposing of the used chemicals care should be taken as to where you put them.

If you have a sink in your class, use plenty of water to wash the waste away.

If you have no sink, and have to pour your waste away outside, see that you pour water, over it afterwards, or cover with soil.
Do not pour where crops may be grown, children play or animals graze.

Page 6

Experiment 2.

Each pair of pupils will need:

2 cm magnesium ribbon
a small piece of steel wool about 3 cm x 1 cm which will fit into a straw when screwed up into a tube
2 plastic straws (try not use blue ones)
2 small pieces of filter paper about 2 cm x 1 cm (these measurements need not be accurate)
methylene blue indicator (diluted type)
water
scissors
scalpel
ruler

Before the pupils do this experiment, practise the closing of the straws (Instruction 1) for yourself to make sure that you know exactly how to do it. It is absolutely necessary that the straws be completely sealed.
The pupils should observe the rusting of the steel wool and the colour change of the methylene blue within a day or two. The magnesium ribbon will not be so satisfactory but they should see tarnishing after some time. It is not likely that the magnesium straw will suck up water to 1/5 of the air space.

While the pupils are waiting to observe their results, they should write a report.

Exercise 2. page 8

1. Length of airspace in steel wool straw at the beginning = ... cm.
2. Length of air space in magnesium straw at the beginning = ... cm.
3. After some days, length of air space in first straw = ... cm.
4. After some days, length of air space in second straw = ... cm.
5. Therefore fraction of air used by rusting steel wool = ... cm.
6. Colour of filter paper in straws changed from ..... to .....
7. This told me that the gas used by the steel wool and by the magnesium was .....
8. The ..... gas must make up a ..... fraction of the air.

Answers to Exercise 2.

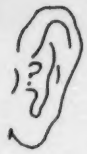
Questions 1 and 2, 3 and 4: as measured by the pupils. However the "steel wool" straw should end up with an air space measuring about 4/5 of the space at the beginning of the experiment.

5. 1/5
6. Blue to white
7. Oxygen
8. Oxygen, 1/5

N.B.

Pupils may be confused by the use of the terms tarnish and rust. Tarnish is the English word which is used to describe any metal surface which is discoloured. Rust is the word used specifically for iron which has tarnished.

Page 9 Looking at calcium



The purpose of this demonstration is to prove to the pupils that calcium is in fact a very shiny substance. In air, it tarnishes easily. It is not recommended that you use the word metal' at this stage of the unit.

Calcium is very reactive, so you should not hold it in your hand. Hold it in the peg at all times. If some should get on your skin, wash it off straight away with plenty of water. Please make this clear to the pupils before they begin Experiment 3.

The calcium will be supplied as <u>small</u> lumps. The pupils should hold the calcium lump so that it sticks out sideways from the peg. This will make it easier to hold over the flame without burning the peg. See diagram.

Page 9 Experiment 3. Burning Calcium

Each pair of pupils will need:

piece of calcium
scalpel

Make sure that the pupils scratch the calcium over an area which is big enough to be able to see the white oxide forming <u>clearly</u> on burning.

Exercise 3 page 10

1. In experiment 3 the elements ..... and ..... took part in a reaction.
2. A white substance ..... was formed in the reaction.
3. Write a chemical equation of this reaction.
4. Write a chemical equation for the reaction between iron and oxygen.
5. Write a chemical equation for the reaction between magnesium and oxygen.

Answers to Exercise 3.

1. Calcium, oxygen.
2. Calcium oxide
3. Calcium + oxygen = calcium oxide
4. Iron + oxygen = iron oxide
5. Magnesium + oxygen = magnesium oxide

Experiment 4. Burning carbon. Page 12

For this experiment you will have to bring some charcoal to school. It has not been supplied in your kit because it is readily obtainable all over Zimbabwe. You will need to locate some charcoal which has fairly large pieces, about 3 cm sided cubes. These will be needed in Part 3 of the unit. For this experiment, only small amounts are required by each pair of pupils. About 1 spatula of CRUSHED charcoal will be enough. Big pieces will not burn easily, so the pupils will not get the desired result.

The bicarbonate indicator is made ready as follows:-

To make up the class bicarbonate indicator solution

You will need:

bottle of bicarbonate indicator
water
clean bottle
measuring cylinder
bicarbonate of soda (sodium bicarbonate)
spatula/stirrer

Pour 10 ml bicarbonate indicator into the cylinder. Add water up to the 100 ml mark.

The colour of the indicator in your bottle is yellow. When you add water, it may turn to purple, which is the colour needed. However, water types vary from one district to another, and it may not change to purple.

If it does not change to purple, you should wet the tip of the stirrer with water. Touch the surface of the bicarbonate of soda with this wet end. This way you will be able to pick up one or two crystals of soda. Stir these crystals into the indicator solution. It should now turn from yellow to purple. Please do this very carefully and only put the smallest amount of soda possible. If you use too much, the indicator may not change in class experiments

You can now put this solution in the clean bottle. It will keep for at least a month.

Do not forget to label it "Class bicarbonate indicator solution."

Give the pupils 5 drops of this class bicarbonate indicator solution.

N. B.

Note: The indicator dish' mentioned in the experiment is in the basic kit box. It is in fact the little inner lid for the burner, which has not been used before. The bicarbonate indicator will take a little time to absorb the carbon dioxide. If these lids have been lost make a small cup from aluminium foil.

Do not allow pupils to heat for too long because all the bicarbonate indicator will boil away They should heat on the opposite side of the evaporating dish

Exercise 4.

1. Before I burned the carbon, the colour of the bicarbonate indicator was .....

2. After making carbon dioxide, the bicarbonate indicator colour was .....

3. Therefore in the presence of carbon dioxide the bicarbonate indicator turns from ..... to ..... colour.

Answers to Exercise 4.

1. reddish blue
2. yellow
3. reddish blue to yellow.

Do not forget that pupils should write a report for EVERY experiment they do!

Page 14 Experiment 5.

Each pair of pupils will need:

candle (short piece, as in previous experiments)
bicarbonate indicator

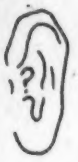
Exercise 5. page 15

Describe this experiment, mentioning the indicator change and your conclusion.
(Conclusion means: what you decided the experiment told you)

Answer to Exercise 5:

The indicator turns yellow. This shows that carbon dioxide is formed when a candle burns, which means that the wax fuel contains the element carbon which reacted with the oxygen in the air.

☆☆☆ Page 15 Two tests for gases. Pupils should learn these tests well.



Page 15 Universal Indicator Paper.

Before pupils do Experiment 6, you should show them Universal Indicator Paper and explain how it works. This paper gives different colours in different kinds of chemical substances In fact it indicates acids and bases, but do NOT tell the pupils this at this stage. They will learn about it in the next Experiment.

You might like to read the following to your pupils:

"This special paper enables us to classify chemical liquids by seeing the colour of the paper when it is dipped into the liquid. To help us to explain the colour, a scale called the pH scale is used. You can see that the scale is marked next to the colours. A red colour has a pH value of 1 or 2, while a blue colour has a value of pH nearer to 14. You can write down the pH value of a liquid by dipping the paper into the liquid and finding the NEAREST colour on the chart. So you will have to observe very well! You do not need a long piece of paper for this: tear off just enough to dip in a corner without wetting your fingers. You can now try it for yourself."

Note: If you have not met the term 'pH' before, the two letters are pronounced separately : p-H.

Page 16 Experiment 6 Universal Indicator Paper

You will need to make up the following liquids before the lesson:

1. Hydrochloric acid
(ALWAYS add acid to water NEVER add water to strong acid)
In a 250 ml flask put 250 ml water. Using your 5 ml measure, add 20 ml hydrochloric acid SLOWLY AND WITH CAUTION. Remember acid burns clothes and skin!
Stir with a spatula. Warn pupils about acids when they come to test this solution.
You will need to keep this flask for the next experiment.

2. Water. This can be in a borrowed graduated beaker.

3. Sodium carbonate solution

In a conical flask put 250 ml water. Stir in 5 spatulas sodium carbonate and stir well until all dissolved. You will need to keep this also.

4. In a graduated beaker, put 25 ml water. Stir in ½ spatula copper sulphate, until all has dissolved. Keep this for Experiment 8.

5. Into your third conical flask, put 250 ml water. Using a dropper, add 1 drop ammonia solution. Stir well. Then pour 150 ml out into a storage container for later use. Add another 150 ml water to the flask. The solution is now ready for use. It will be VERY dilute indeed.

6. In a graduated beaker, put 25 ml water. Add ½ spatula sodium chloride and stir well, until all has dissolved. Keep this for Experiment 9.

When you have made all the solutions, check their pH values. You should find that they are approximately as follows:

1. Hydrochloric acid: pH = 1 to 2
2. water: pH = 7
3. sodium carbonate solution: pH = 11
4. copper sulphate solution: pH = 4
5. ammonia: pH = 8
6. sodium chloride solution: pH = 7

When pupils have finished testing the solutions, put some ammonia solution in a graduated beaker for Experiment 8. Throw away the rest of the ammonia and wash out the flask very well. Make up a second flask of sodium carbonate EXACTLY as before, ready for the next experiment.

Exercise 6. Part 1 page 16

Fill in the table:

Substance	pH
Hydrochloric acid	
water	
sodium carbonate solution	
copper sulphate solution	
ammonia	
sodium chloride solution	

Exercise 6. Part 2.

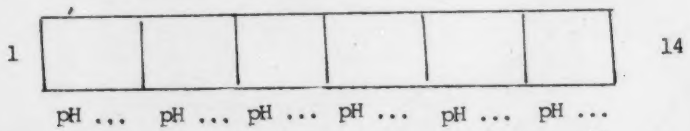
Fill in the Table:

Acids (acidic substances) pH less than 7	Bases (basic substances) pH more than 7	Neutral substances pH = 7

A Suggestion (Experiment 6)

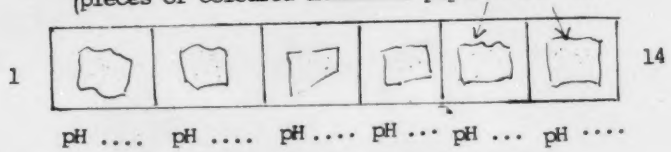
Make up a tin of flour and water paste.
Tell the pupils to keep their pieces of universal indicator paper which they have used to find out pH values in Experiment 6 and allow them to dry.

They can copy this diagram into their books



They will know the pH value for each piece of indicator paper. They can stick it, using the flour and water paste, in the appropriate square, writing the pH they got underneath. In this way they will have a permanent colour record of a pH scale, which may look like this.

(pieces of coloured indicator paper stuck in



Page 17 Experiment 7.

You will need:

flask of hydrochloric acid

2 flasks of sodium carbonate solution from previous experiment

Each pair of pupils will need:

Exactly 25 ml sodium carbonate solution in their graduated beakers

About 25 ml acid in their plastic cup

You will probably run out of acid. If this happens, make up a second flask as before without bothering to wash the flask out. This is a quick and easy preparation.

Exercise 7. page 17

1. When I added the acid to the base, I observed .....

2. This means that .....

3. My pH readings were :

	pH
sodium carbonate alone	
" " + 5 ml acid	
" " + 10ml "	
" " + 15ml "	
" " + 20ml "	
" " + 25ml "	

4. At the neutral point, volume of acid added was about ..... ml.

Conclusion:

Answers to exercise 7

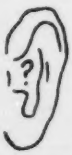
1. Fizzing, bubbling etc.
2. A chemical reaction is happening
3. Pupils should observe a gradual change of pH values from 11 to 2 (or less). The point at which they pass through 7 will depend on how carefully they are doing the acid addition, but will be between 10 and 20 ml.

4. They should be able to guess the amount of acid that would have given a reading of 7.

Conclusion: when an acid reacts with a base it can make a neutral substance.

A simple pupil model page 18

Choose an equal number of boys and girls - perhaps 10 of each. Place the boys on one side of the class, the girls on the other. Tell the pupils that the boys represent the acidic particles in a solution, and the girls represent the basic particles in another solution.



The pupils should now move together.
Tell them that the acid and base solutions are being mixed.

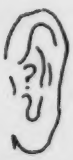
Each boy should now pair off with a girl (stand next to a girl)

After they have done this you can ask the class "Are there any particles not paired off?" They should answer "No" Say to them "So there are no spare acid particles or spare base particles in the solutions? What does this mean?" Try to guide them into deciding that the solution is now neutral. The acidic particles have paired off with and neutralized the basic particles

Now do the model again, choosing say 14 boys and still 10 girls. When the boys and girls pair off, there will be extra boys.

Ask the class. Are there any particles left over? The answer will be "Yes - some boys." Ask "What sort of particles are the boys" The answer should be "Acidic" Ask what this means : The answer they should give is "The solution is acidic because there are more acidic particles than basic particles.

Do the model a third time, choosing more girls than boys. After the pupils have paired off, there will be extra girls.

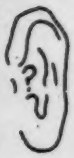


Discuss this with the class asking them:

"Are there any particles left over?" They should answer "Yes" - some girls"

Ask What does this mean?

The answer should be; The solution is basic, as there are more basic particles than there are acidic particles.



Page 1 8

The gas is Carbon dioxide. You should demonstrate this to the pupils.

You will need to have ready:

Plastic beaker half full (25 ml) of

Sodium carbonate solution

Plastic cup containing 25 ml hydrochloric acid

Small indicator dish with some purple bicarbonate indicator in it

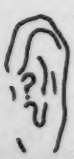
Boiling tin.

This is a repeat of Experiment 7. However, you will be testing the gas which comes off as the solution is neutralized.

Therefore have the indicator dish placed next to the beaker of sodium carbonate solution.

Add 5 ml of hydrochloric acid and immediately cover the beaker and indicator dish with the boiling tin. Wait a few minutes then remove the tin. The bicarbonate indicator should have turned yellow. If it does not, repeat after adding another 5 ml hydrochloric acid to the sodium carbonate solution.

Ask the pupils "What gas is being released, if it turns the indicator from purple to yellow?" They should answer "The gas is carbon dioxide."



Page 18 Limestone and marble must be carbonates. In fact they are calcium carbonate.

Page 18 Experiment 8. Parts I, II III

Each pair of pupils will need:

Water
Piece of calcium about 2 cm long
Piece of magnesium ribbon about 2 cm long
½ spatula of sulphur in their evaporating dish

Warn children NOT to look directly at the magnesium burning as it will hurt their eyes.

page 21

The last part of this experiment is finding the pH of a carbon dioxide solution. The pupils should be encouraged to think up their own method. They might choose one of the following:

(i) burning charcoal (following the method for sulphur)
(ii) burning a candle
(iii) adding acid to sodium carbonate and collecting the gas.

Try to have the necessary materials on hand for any of these methods.

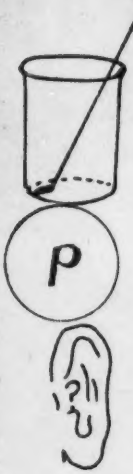
Exercise 8. page 19

Part 1. pH of calcium oxide solution =
Part 2. pH of magnesium oxide solution =
Part 3. pH of sulphur dioxide solution =
Part 4. pH of carbon dioxide solution is deduced to be .....

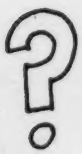
Answers to Exercise 8:

1. basic (more than 7) (they should get a value of about 10)
2. " " " " (" " " " " 8)
3. acidic (less than 7) (" " " " " 4)
4. acidic (less than 7 (" cannot say more than this by deduction)

Page 21 Experiment 9: pH of jiffy juice and toothpaste



You will need to make up a jiffy juice solution as you did for Al. The toothpaste solution can be made by stirring a little toothpaste into water. The pH of jiffy juice is acidic (less than 7) while toothpaste is basic (more than 7). The jiffy juice reacted with the toothpaste when in the mouth and neutralised it. Similarly, the 'acid in eyes' substance is alkaline so that it neutralises any acid which is in the eye, and the substance for 'alkali in eyes' is acidic. The word 'alkali' is very similar in meaning to the word 'base'.



Page 22 Answers to 'How much do you know?'

1. oxygen and silicon
2. silicon oxides
3. methylene blue
4. colourless to blue
5. oxygen and nitrogen
6. bicarbonate indicator
7. bluish red to yellow
8. carbon dioxide, acidic
9. sulphur dioxide, acidic
10. magnesium oxide, basic
11. calcium oxide, basic
12. 1, and just less than 7
13. just more than 7, and 14
14. as per text

PART 2: METALS AND NON-METALS

Page 23 Experiment 10: Metals and non-metals

Each pair of pupils will need:

chemicals as detailed in the study guide. The carbon rods are supplied in the Form II chemicals. Small pieces of cotton wool may be taken from the First Aid Kit. The piece of candle wax need not be very large: about 1 cm cube will do.

List of requirements per pair of pupils for Experiments 10, 11, and 12.

Carbon rods
cotton wool
3 cm magnesium ribbon
2 cm^2 aluminium foil
1 spatula sulphur (in evaporating dish)
2 cm calcium
1 iron nail
2 cm copper wire (if you have none left you can borrow it from the electric motor kit, or buy a piece of electric flex, and strip the copper wire out of it).
used match stick
piece of candle wax

Pupils will make their groups by comparing shinyness, feel, previous information etc. The purpose of this experiment is to gradually bring out the essential characteristic of metals and non-metals.
Pupils should end up with the following groups:

Acidic oxides:	Basic oxides
carbon, cotton wool, sulphur, matchstick, candle wax	magnesium, aluminium, calcium, iron, copper lead

TABLE 1 page 24

Substance	Oxide	Heat from the burner comes through quickly (yes/no)	Shines when scraped (yes/no)	Bends without breaking and stays bent (yes/no)
magnesium aluminium calcium iron copper lead				
carbon cotton wool sulphur matchstick candle wax				

Pupils should record 'basic' for the whole of the first group and 'acidic' for the second group. They should also find that metals get hot quickly, therefore they conduct heat well, whereas non-metals do not. Metals bend easily and shine when scraped.

Exercise 9. Page 25

From my results I can say that the CHARACTERISTICS of metals are

1.
2.
3.
4.

Non-metals have the following characteristics:

1.
2.
3.
4.

Answers to Exercise 9. (Any order should be accepted.)

Metals	1.	form basic oxides
	2.	conduct heat well
	3.	shine
	4.	bend easily
Non-metals	1.	have acidic oxides
	2.	do not conduct heat well
	3.	do not shine
	4.	do not bend easily

Further reactions of metals. Aluminium has been excluded from the metals tested by the pupils because its reactions are misleading. It is in fact very reactive but is prevented from showing this because of a tough unbreakable covering of transparent aluminium oxide which it has because it is so reactive.

Table 2.

Metal	Reacts with cold water (yes/no)	Reacts with hot water (yes/no)	Reacts with cold acid (yes/no)	Reacts with hot acid (yes/no)
magnesium				
calcium				
iron				
copper				
lead				

Experiment 13: Reacting metals with water Page 26

Pupils should observe a fairly quick bubbling reaction with calcium. Magnesium will be slower. Other metals will not react. They should NOT test the calcium in hot water: a reaction in cold water means that it will be very reactive and may have a violent result in hot water. ON NO ACCOUNT SHOULD THE CALCIUM BE PUT INTO THE ACID IN EXPERIMENT 14. It is most important that pupils realise that a metal which reacts with cold water will be more reactive in hot, and even more so in acid. In this way they are building up an idea of activity and it is logical to write for calcium that it reacts with hot water and with acid WITHOUT TESTING TO PROVE IT.

Magnesium should react well with hot water. Other metals will not react and may be carried forward to Experiment 14.

Experiment 14: Reacting metals with acid Page 27

Each pair of pupils will need:

about 15 ml hydrochloric acid made up as you did for experiment 6.

This acid is very dilute. It is likely that you will not get a reaction in the cold, but iron will react with the hot acid. Pupils may also note a 'cleaning' effect with their evaporating dishes - it will be nice to have them clean and shining but don't use acid too often or the dishes will be eaten away!

Exercise 10 Page 27

Using your results, list the metals in the order of reactivity, starting with the most reactive. This is called the 'Activity Series of the metals'.

Answers to Exercise 10

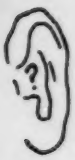
On their results, pupils should get: calcium
magnesium
iron
lead and copper

N.B. It is not possible from this experiment to decide which comes first lead or copper

Page 28 Experiment 15.

Make up some dilute hydrochloric acid before the lesson as follows:

Into a 250 ml. conical flask put 65 ml water. Slowly add 5 ml hydrochloric acid. Give each pair of pupils 2 ml of this dilute acid and 2 cm piece of magnesium. Have your first aid kit ready in case of acid in the eyes . The pupils should wash their hands after the experiment.



The discussion

Ask the pupils "Where do you think the hydrogen came from? Could it have come from the magnesium metal?"

Answer "No it could not have come from the metal as magnesium is an element.
(They should know this)

It must have come from a compound containing hydrogen. Therefore the acid must be a compound containing hydrogen and the hydrogen came from the acid.

(Hydrochloric acid is actually a compound of the 2 elements hydrogen and chlorine).

Page 29 Experiment 16: Reacting metals with sulphur

Each pair of pupils will need:

chemicals as detailed in study guide.

This experiment is carried out like the iron/sulphur experiment in Unit C1, except that pupils will not hold the parcels in their hands. All sulphides in this experiment are black.

Exercise 11 Page 30

1. Describe the appearance of the mixture and the compounds that you made in this experiment.

2. Complete the following equations

copper + ... = copper sulphide
iron + sulphur = ...
..... + sulphur = lead sulphide

Answers to exercise 11

1. As observed.
2. Sulphur, iron sulphide, lead.

"How much do you know?" page 31
answers

1) Conduct heat, bend, are shiny, form basic oxides

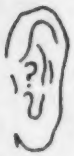
2) Calcium, magnesium, iron, lead and copper

3) As experiment 15

4) A lighted match causes it to burn with a "pop sound".

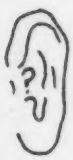
PART 3: THE EXTRACTION OF METALS

Activity series Page. 33



The level at which metals may occur on their own begins at copper. Traces of pure copper ('native copper') are found in many parts of the world, including Zimbabwe, However most copper is found in compounds such as the sulphide. Rather more 'native silver' can be found, while gold usually occurs by itself. There are many gold mines in Zimbabwe.

Page 33 Uses of iron

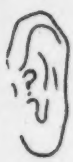


There are many different uses of iron which you probably know already. However, as a guide, here are a few:

cast iron pots
telegraph poles
railway lines etc.

Page 34. Give out the pieces of iron ore from the rock samples kit, for the pupils to look at.

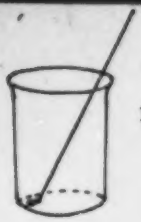
Page 38 Use of a blowpipe



You will need to practice this before showing it to the pupils. The diagram in the study guide shows you how to direct the flame onto the charcoal block.
Do not 'puff' but blow steadily to get the right result and to avoid blowing all the iron oxide out of the block!

Experiment 17: Extraction of iron page 38

Collect 20 blocks of charcoal from old fires. Each block should be at least 4 cm x 3 cm x 2 cm. You could ask the pupils to try to bring their own.



Each pair of pupils will need:

1 spatula iron oxide from the supply of chemicals
a charcoal block as explained previously
blowpipe

Have a magnet available for pupils to test the product!

Exercise 12 Page 38.

1. Write a complete description of what you did in this experiment. Include any observations that you made.

2. How would you find out if you had iron left on your charcoal? Think back to unit C !

3. What happens in the blast furnace?

Answers to Exercise 12

1. As in text
2. If any iron is left it will be attracted to a magnet
3. As in the text.

Page 39.

Pass around the pieces of copper ore from the rock sample kit.
Tell the pupils:-

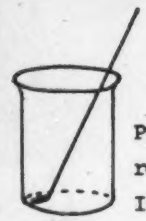
These pieces are of rock which is called CHALCOPYRITE or copper pyrites.
It is copper bearing ore. The element copper has reacted with sulphur so it is present as the compound copper sulphide

Rock like this is found at Headlands, Kadoma and Sabi. There are big copper mines at Alaska Mine, Mangula and Inyati (Manicaland). Most of the copper mines are in the northern part of Zimbabwe.

Copper is economically important as an export which brings in money to this country.

Experiment 18: Purity of Copper page 39

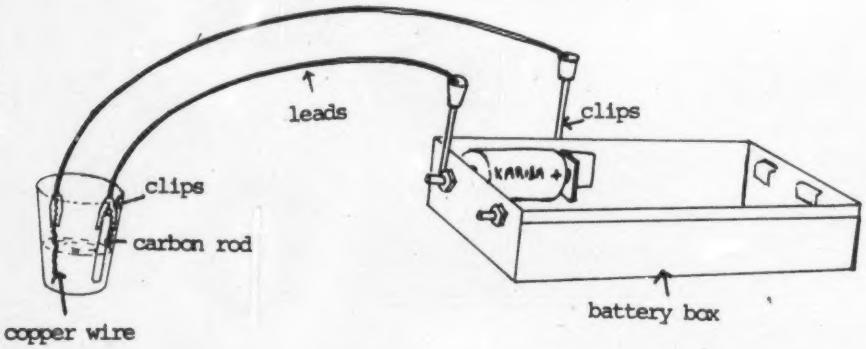
Each pair of pupils will need:



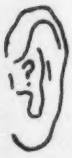
chemicals and apparatus as detailed in the study guide If you have no copper turnings you will have to use the copper wire in your Form 2 kit. You can break it up into pieces. Pupils should observe a coating of copper on the carbon rod within a short time.

If they do not, they may have their leads the wrong way round. Try this experiment the day before to make sure you know how to connect everything properly.

This picture will help you to set up the experiment.



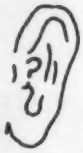
This experiment illustrates the method by which copper is purified. In the industrial process a thin sheet of pure copper is used to collect the copper from the impure copper sheet. Pupils use a carbon rod for this purpose so that they can observe the fresh coating of pure copper. It is worthwhile leaving at least one experiment running overnight to show that the wire sample becomes smaller as its copper is transferred to the carbon rod. Emphasise to the pupils that this is a chemical reaction with energy provided from electricity. The copper sample (wire) used in this experiment is of course already pure and is only used as a demonstration of the industrial process.



Exercise 13 page 39

Explain what is happening to the copper wire in this experiment.
What did you observe on the carbon rod?

Don't forget that pupils should be writing complete reports of each experiment!



Page 40 Uses of copper

Some likely answers are:

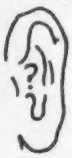
pots, ornaments, coins, wire, etc.

Metallic properties being used here are:

good conduction of heat, shiny appearance, hardness and ability to be bent and shaped, and, in the case of wire, good conduction of electricity. This is another important metallic property.

Gold

As gold has been mined in Zimbabwe for hundreds of years, the pupils may ask about it. You may read this to them:-



"Gold is present in rock as an element. This is because it is unreactive and does not form compounds easily. The gold ore has to be crushed finely. It is then mixed with water and swirled around. The gold is denser than the rock so it gradually sinks to the bottom of the container. When the rock and water is thrown away, the gold is seen as a powder on the bottom of the container.
A lot of rock has to be crushed to get very little gold.
It used to be used to make coins and is used in jewellery."

Page 41 Answers to 'How much do you know?' will be found in the text.

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